Charged Higgs in tH$^+$, H$^+$ -> $\tau\nu$

testing the Jet Energy Corrections

R. Kinnunen

Helsinki Institute of Physics

Data (OODigis) on FNAL User Federation:

10000 events for m_{H+} = 200 GeV, $L = 10^{33}$ cm^{2}s^{-1}

→ 10000 events for m_{H+} = 200 GeV, $L = 10^{34}$ cm^{2}s^{-1}

→ 10000 events for m_{H+} = 400 GeV, $L = 10^{33}$ cm^{2}s^{-1}

10000 events for m_{H+} = 400 GeV, $L = 10^{34}$cm^{2}s^{-1}

No BG samples yet

Previous results for m_{H+} = 200 GeV, $L = 10^{34}$ cm^{2}s^{-1}
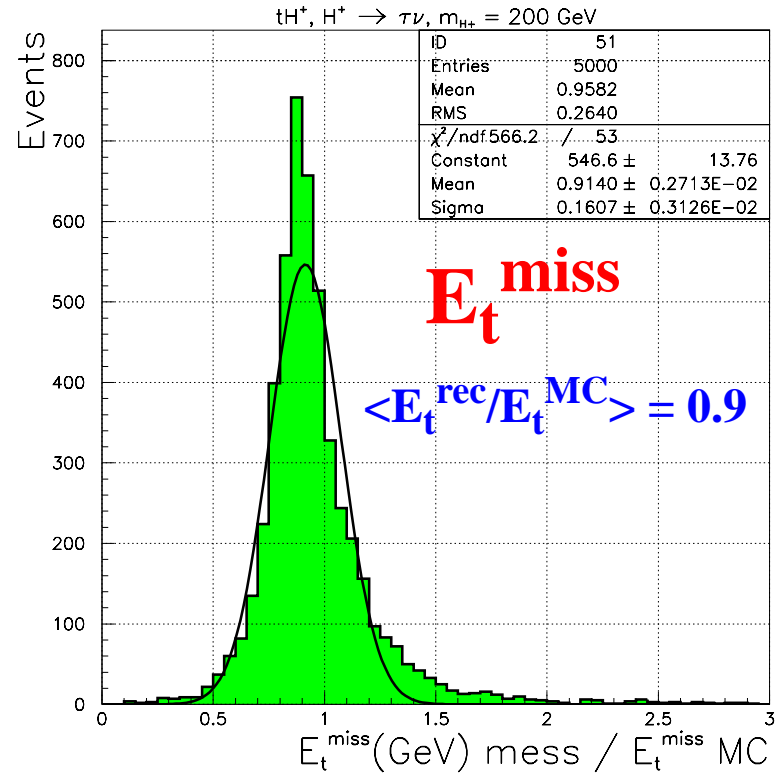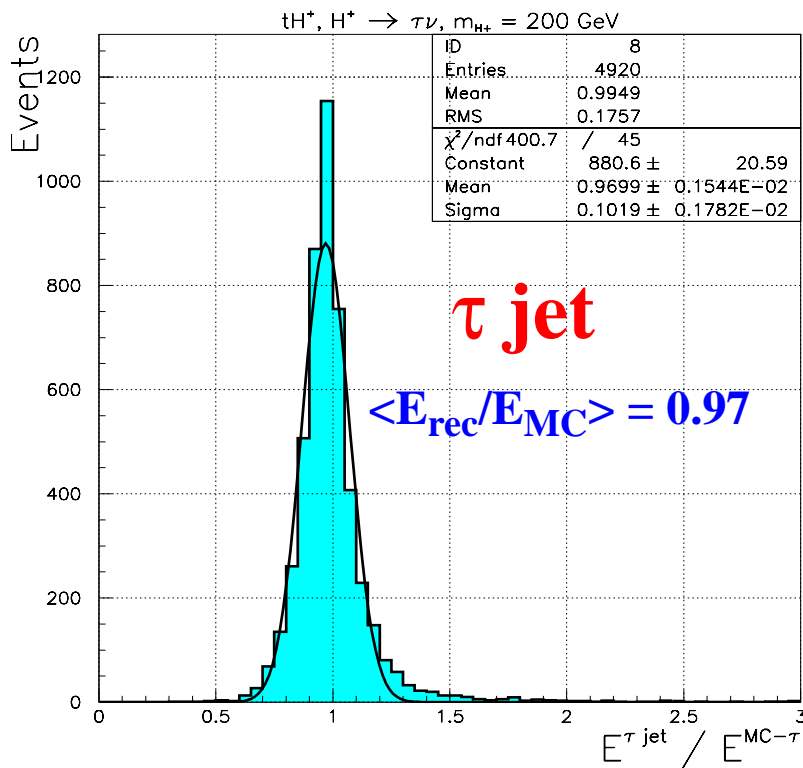
Algorithm:

❖ **Reconstruction of all jets (max. 6) with $\Delta R = 0.5$**

❖ **Selection of b and q jets matching with the directions of generated quarks in top -> $b q \bar{q}$**

❖ **Reconstruction of τ jet around MC τ -> hadrons with $\Delta R = 0.4$**

❖ **Reconstruction of MET**
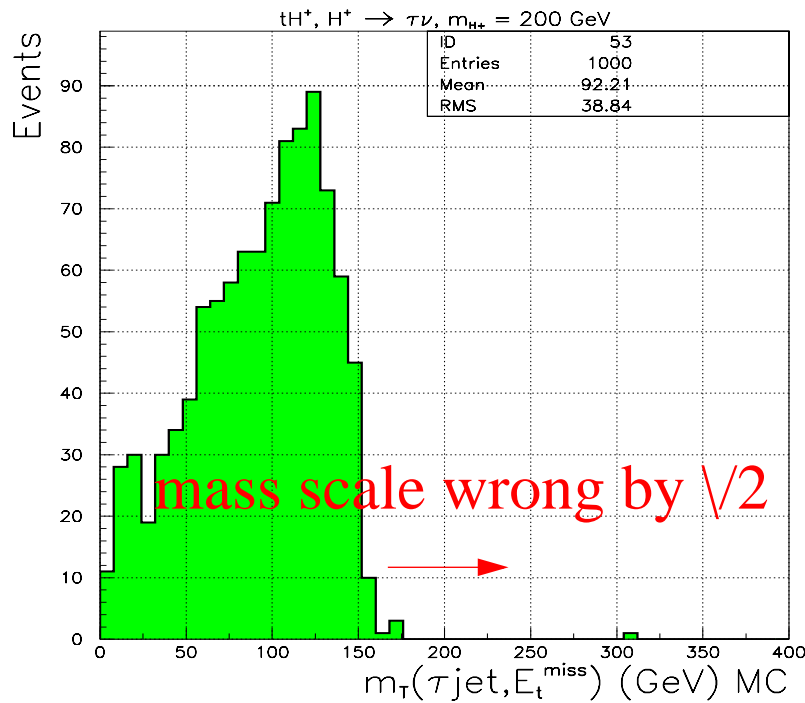
❖ **Use generated tracks**

Reconstructed / generated object

$$m_{H+} = 400 \text{ GeV}, \; L = 10^{33} \text{ cm}^2\text{s}^{-1}$$

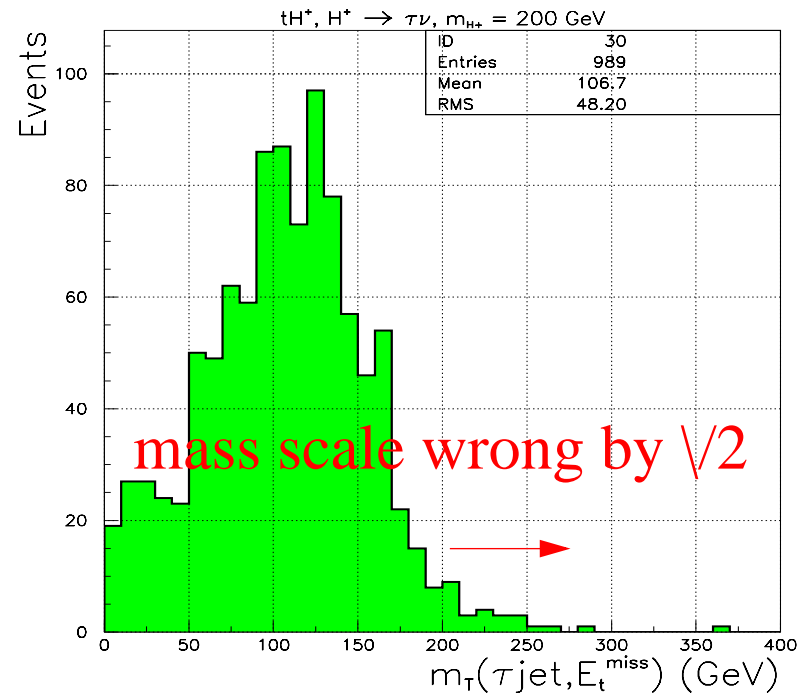## Jet reconstruction cone: $\Delta R = 0.4$ for τ jet

tH$^+$, H$^+ \to \tau\nu$, m$_{H+}$ = 200 GeV

ID	8
Entries	4920
Mean	0.9949
RMS	0.1757
χ^2/ndf 400.7 / 45	
Constant	880.6 ± 20.59
Mean	0.9699 ± 0.1544E-02
Sigma	0.1019 ± 0.1782E-02

τ jet

$<E_{rec}/E_{MC}> = 0.97$

$E^{\tau \, jet} / E^{MC-\tau}$

tH$^+$, H$^+ \to \tau\nu$, m$_{H+}$ = 200 GeV

ID	51
Entries	5000
Mean	0.9582
RMS	0.2640
χ^2/ndf 566.2 / 53	
Constant	546.6 ± 13.76
Mean	0.9140 ± 0.2713E-02
Sigma	0.1607 ± 0.3126E-02

E_t^{miss}

$<E_t^{rec}/E_t^{MC}> = 0.9$

$E_t^{miss}(\text{GeV}) \text{ mess} / E_t^{miss} \text{ MC}$

$m_T(E_t^{\tau\text{-jet}}, E_t^{miss})$, m_{H+} = 200 GeV, L = 10^{34} cm^{2}s^{-1}

Generated τ jet and E_t^{miss}

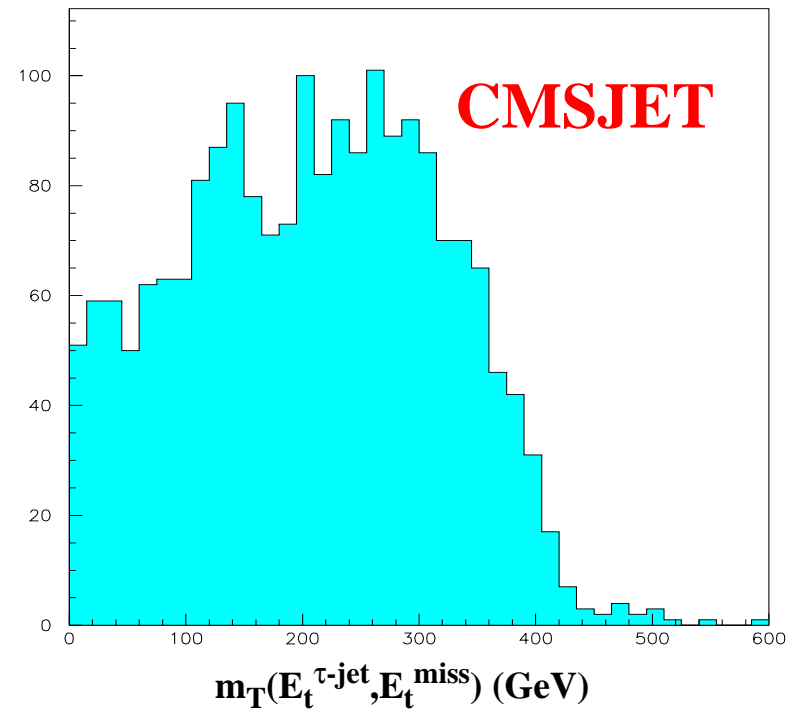**Reconstructed τ jet and E_t^{miss}**

$\Delta R(\tau \to \text{hadrons, jet}) < 0.4$

tH$^+$, H$^+$ $\to$ $\tau\nu$, m$_{H+}$ = 200 GeV

ID	53
Entries	1000
Mean	92.21
RMS	38.84

mass scale wrong by $\sqrt{2}$

$m_T(\tau\text{jet}, E_t^{miss})$ (GeV) MC

tH$^+$, H$^+$ $\to$ $\tau\nu$, m$_{H+}$ = 200 GeV

ID	30
Entries	989
Mean	106.7
RMS	48.20

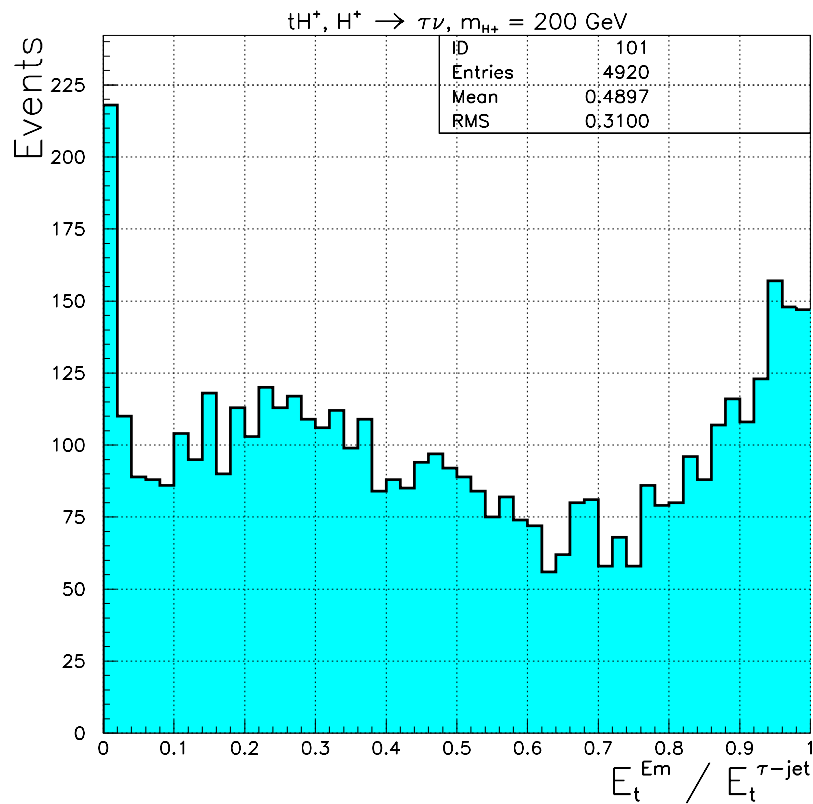mass scale wrong by $\sqrt{2}$

$m_T(\tau\text{jet}, E_t^{miss})$ (GeV)

$$m_T(E_t^{\tau\text{-jet}}, E_t^{miss}), \quad m_{H+} = 400 \text{ GeV}, \quad L = 10^{33} \text{ cm}^2\text{s}^{-1}$$

Reconstructed τ jet and E_t^{miss}, no selection cuts
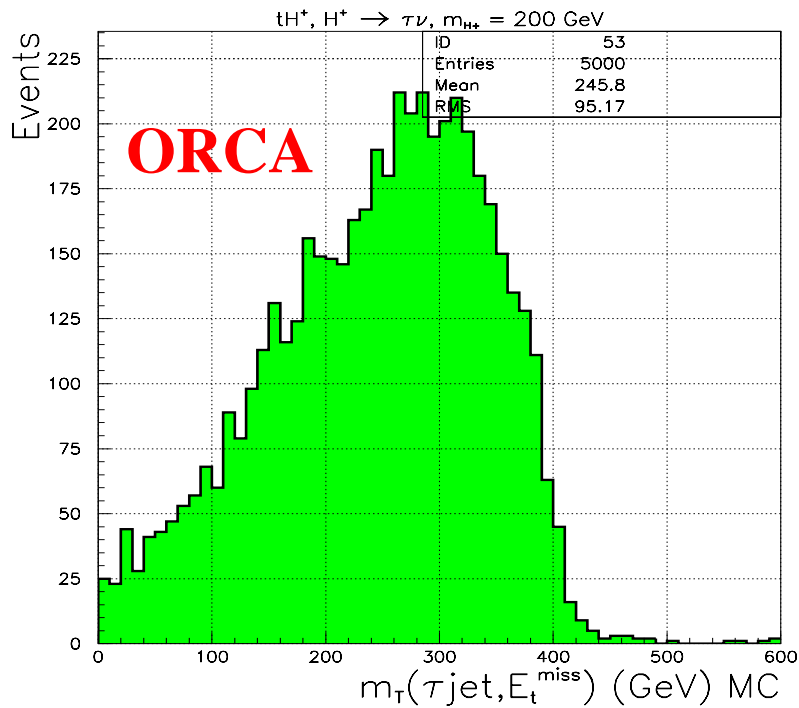
EM component of the τ jet: $E_t^{EM} / E_t^{\tau\text{-jet}}$

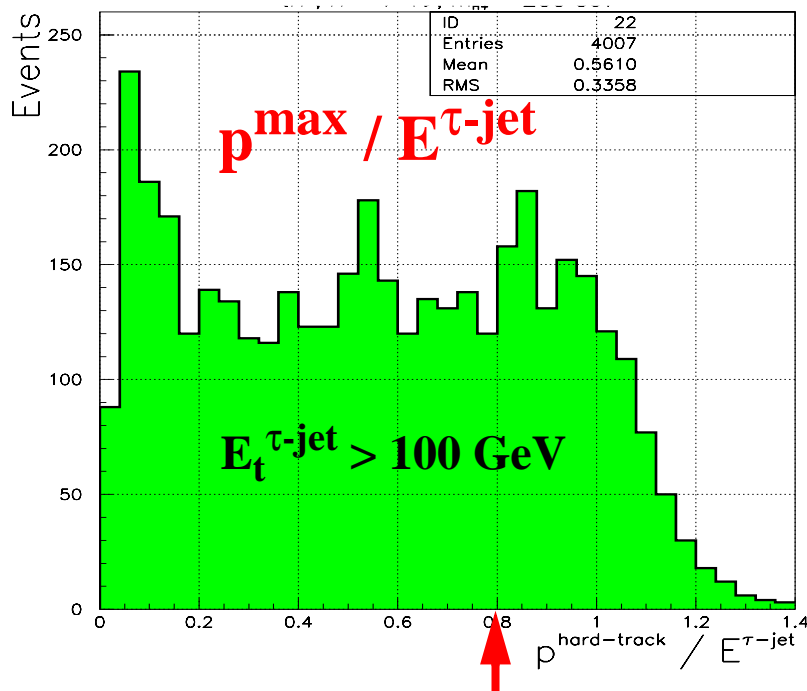## EM energy collected in $\Delta R < 0.4$

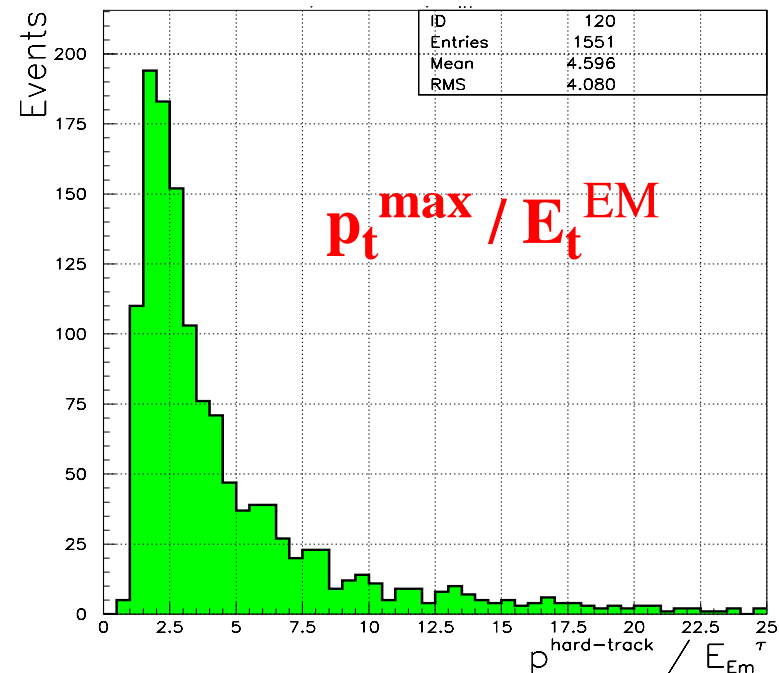**Hard track requirement:**

$p^{max} / E^{\tau\text{-jet}} > 0.8$
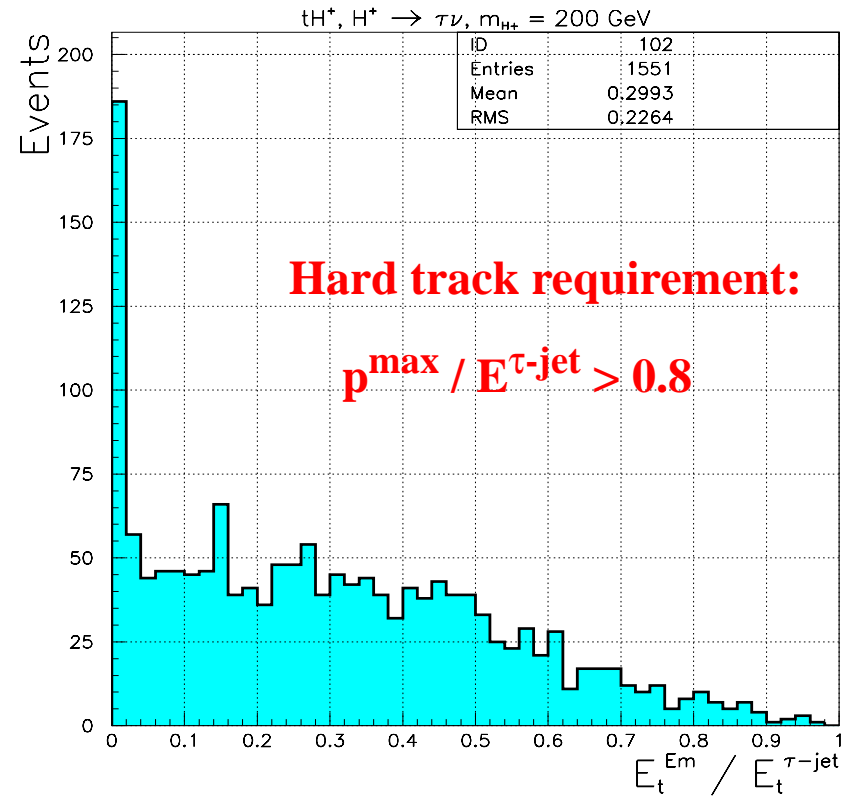
Fraction of τ jet energy carried by the leading pion

Polarization with TAUOLA, all hadronic τ decay modes, MC tracks

$$m_{H+} = 400 \text{ GeV}, 10^{33}\text{cm}^2\text{s}^{-1}$$

$p^{max} / E^{\tau\text{-jet}}$

$E_t^{\tau\text{-jet}} > 100 \text{ GeV}$

p_t^{max} / E_t^{EM}

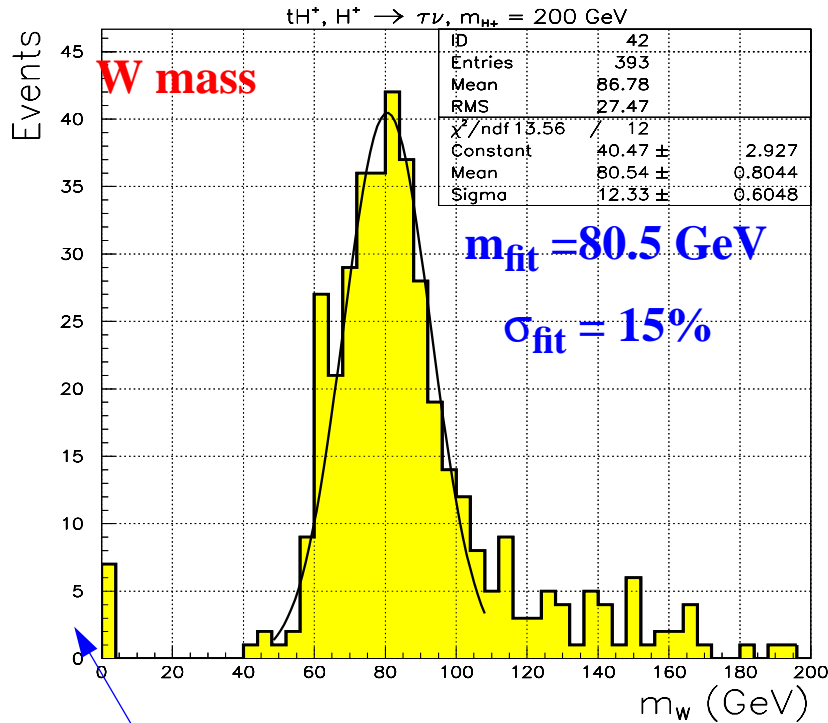|	200 GeV	400 GeV
Efficiency for $p^\pi / E^{\tau\text{-jet}} > 0.8$:	17% (high lum)	30% (low lum.)
efficiency in fast simulation:	26%	

W and top reconstruction, no jet energy corrections

$$m_{H+} = 200 \text{ GeV}, 10^{34} \text{cm}^2\text{s}^{-1}$$

jet reconstruction cone = 0.5, $E_t^{jet} > 30$ GeV

Jets with best matching with W -> qq' and t -> bqq', $\Delta R(jet,q) < 0.4$

q and q' assigned to the same jet ~ 0.7%
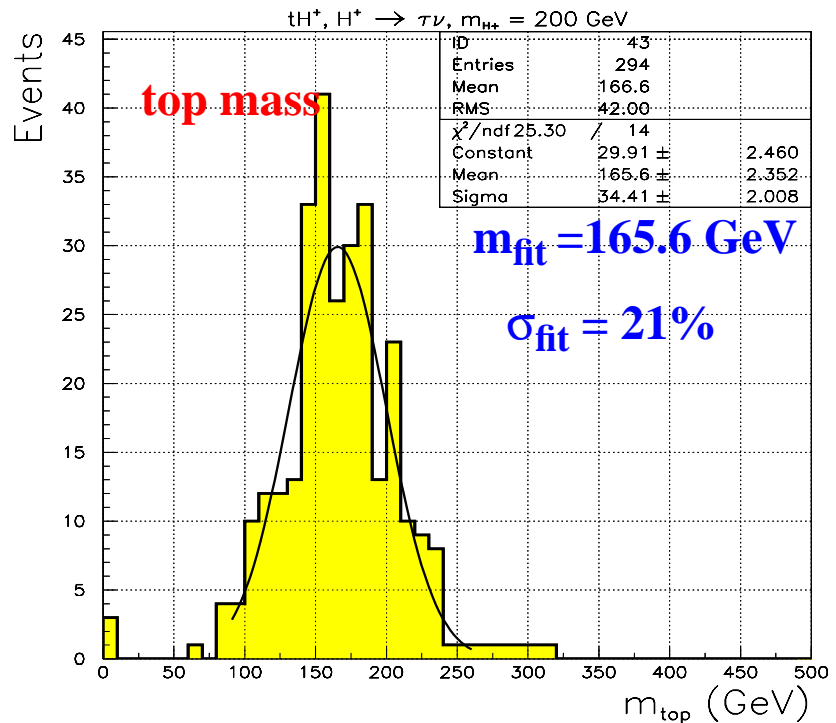
W and top reconstruction with jet E_t corrections for $10^{34}cm^2s^{-1}$

m_{H+} = 200 GeV, $10^{34}cm^2s^{-1}$

jet reconstruction cone = 0.5, E_t^{jet} > 30 GeV

Jets with best matching with W -> qq' and t -> bqq', $\Delta R(jet,q)$ < 0.4

W mass

m_{fit} = 85.2 GeV

σ_{fit} = 16%

top mass

m_{fit} = 178.1 GeV

σ_{fit} = 22%
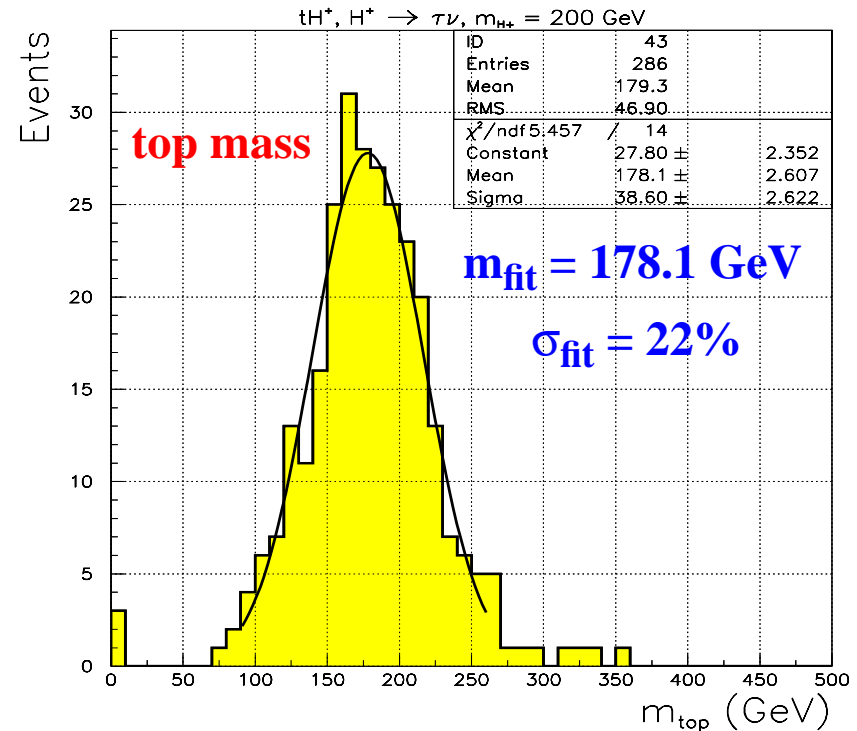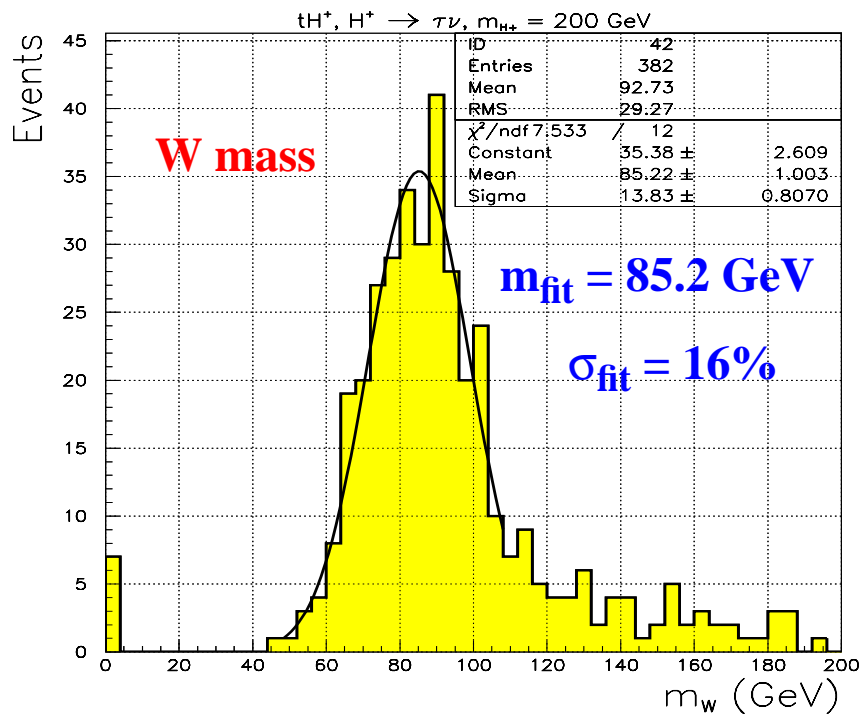
W and top reconstruction with jet E_t corrections for 10^{33}cm^{2}s^{-1}

m_{H+} = 400 GeV, 10^{33}cm^{2}s^{-1}

jet reconstruction cone = 0.5, E_t^{jet} > 30 GeV

Jets with best matching with W -> qq' and t -> bqq', ΔR(jet,q) < 0.4

W mass

m_{fit} = 85.6 GeV

σ_{fit} = 15.2%

ε_{rec} = 44%

top mass

m_{fit} = 180.5 GeV

σ_{fit} = 15.7%

ε_{rec} = 34%
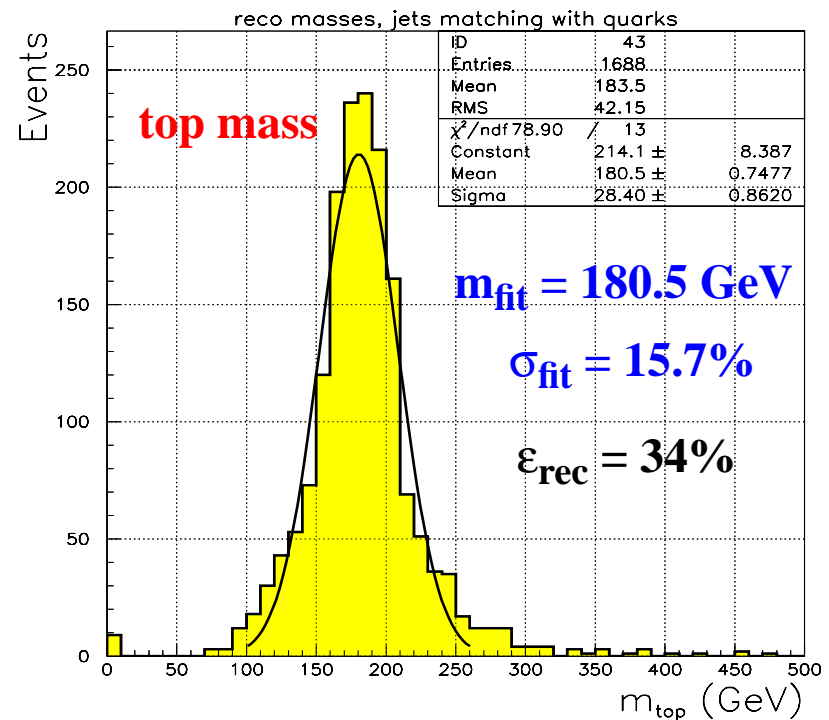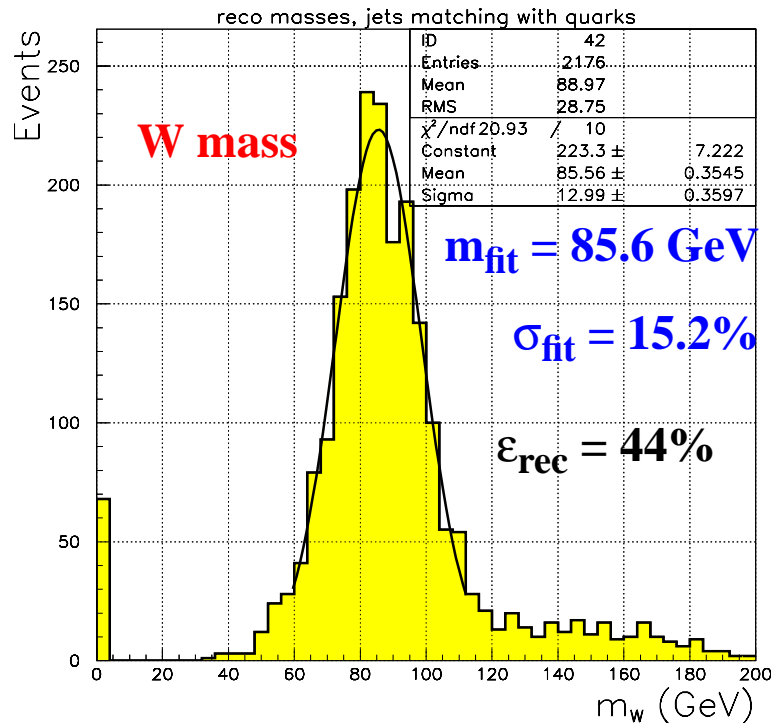
W and top reconstruction with CMSJET, no pile-up

$m_{H+} = 400$ GeV, 10^{33}cm^{2}s^{-1}

jet reconstruction cone $= 0.5$, $E_t^{jet} > 20$ GeV

Jets with best matching with W -> qq' and t -> bqq', $\Delta R(jet,q) < 0.4$

W mass

ID	900
Entries	1496
Mean	83.48
RMS	14.88
χ^2/ndf 4.110 / 12	
Constant	20.30 ±	2.189
Mean	82.81 ±	0.8069
Sigma	9.298 ±	0.7396

$m_{fit} = 82.8$ GeV

$\sigma_{fit} = 11\%$

$\varepsilon_{rec} = 39\%$

m(jet,jet) MATCH

top mass

ID	902
Entries	1022
Mean	178.9
RMS	32.16
χ^2/ndf 3.844 / 5	
Constant	26.69 ±	3.343
Mean	171.3 ±	1.702
Sigma	16.31 ±	1.421

$m_{fit} = 171.3$ GeV

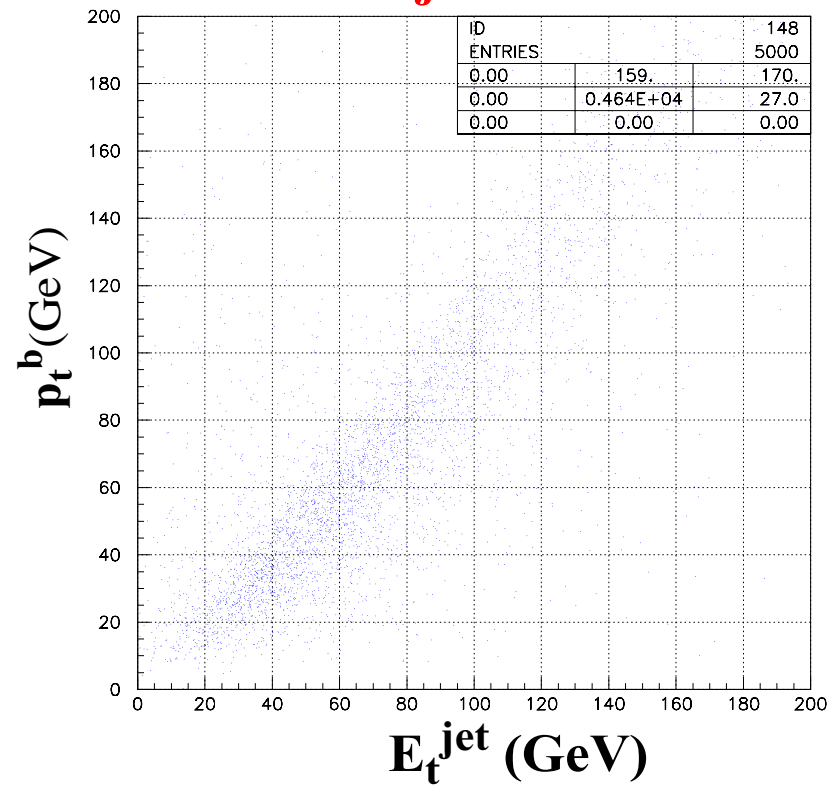$\sigma_{fit} = 9.5\%$

$\varepsilon_{rec} = 26\%$

m(jet,jet,B) MATCH
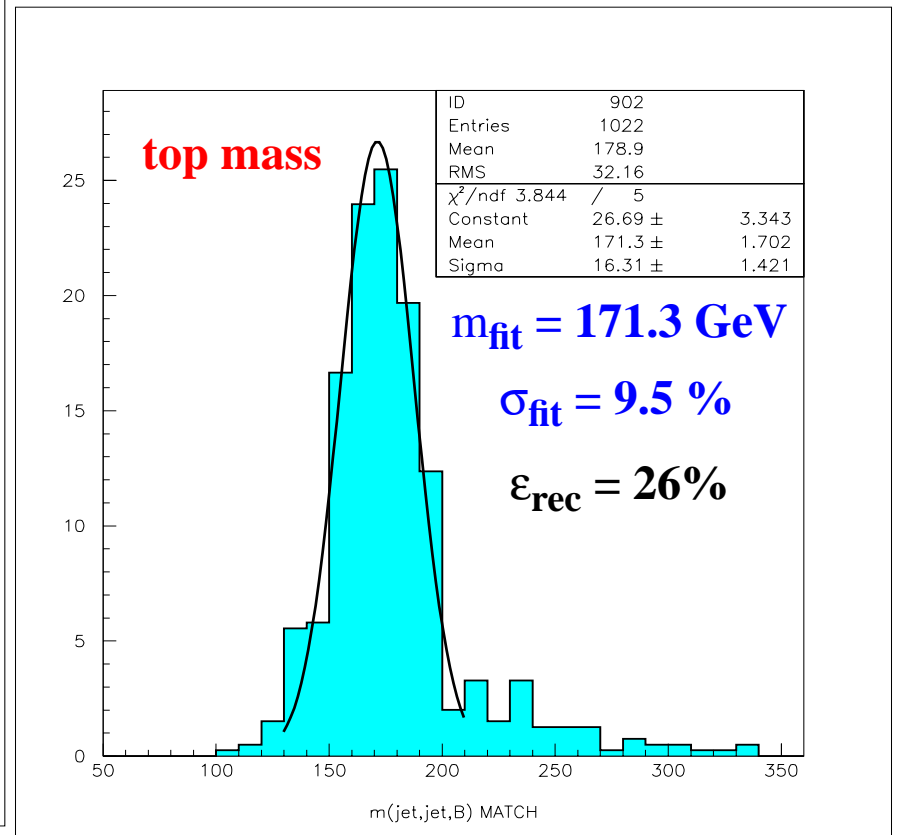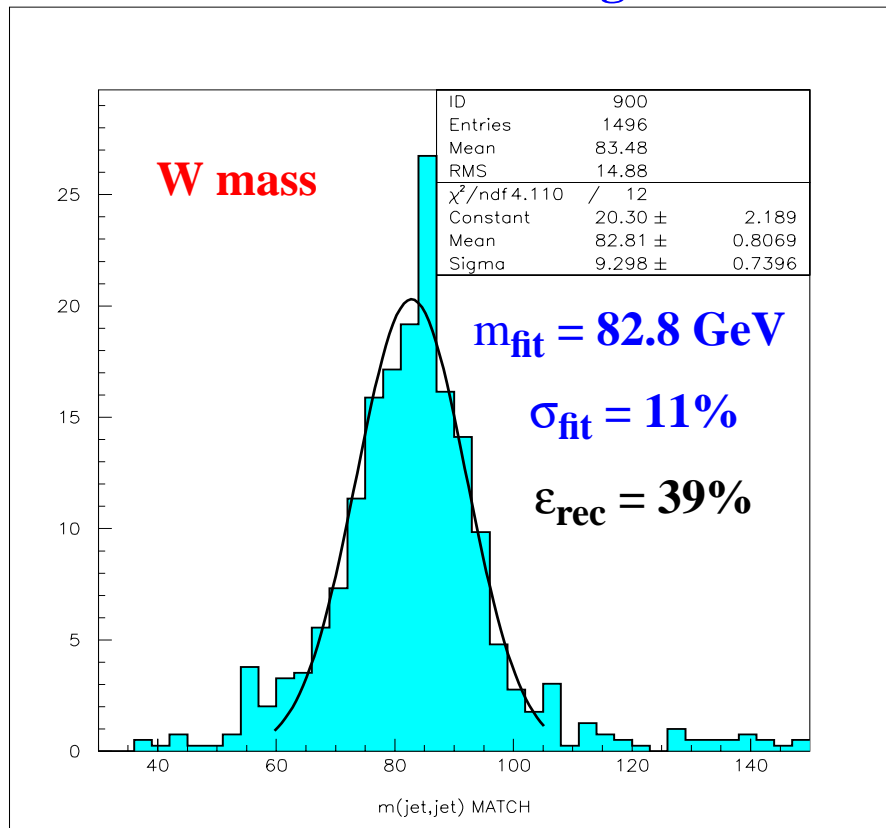
E_t measured jet vs $p_t^{q,b}$

with jet E_t corrections for $10^{33} cm^2 s^{-1}$

q jets
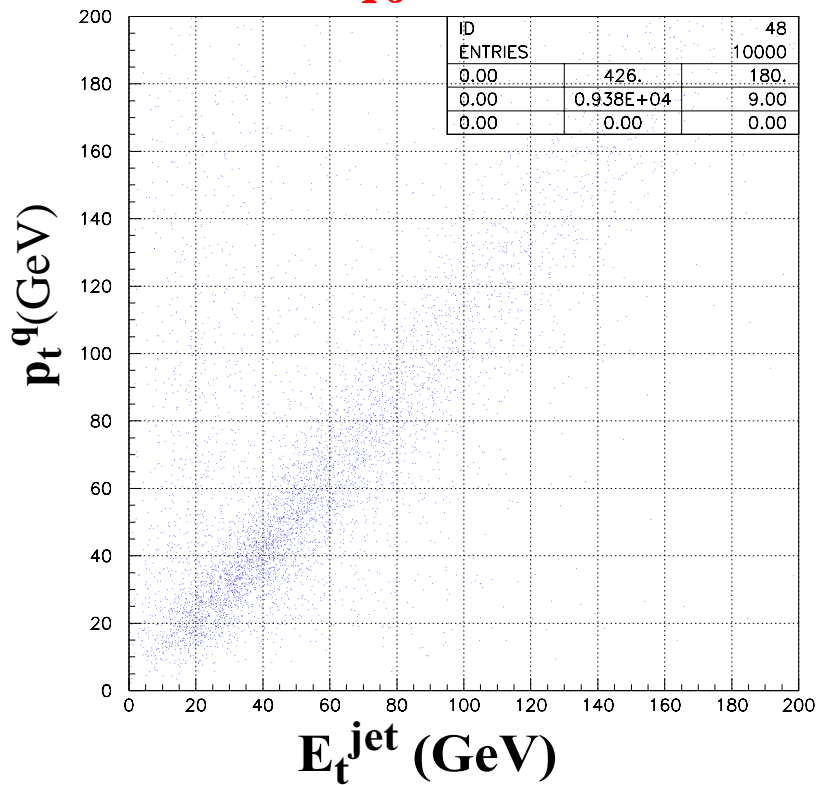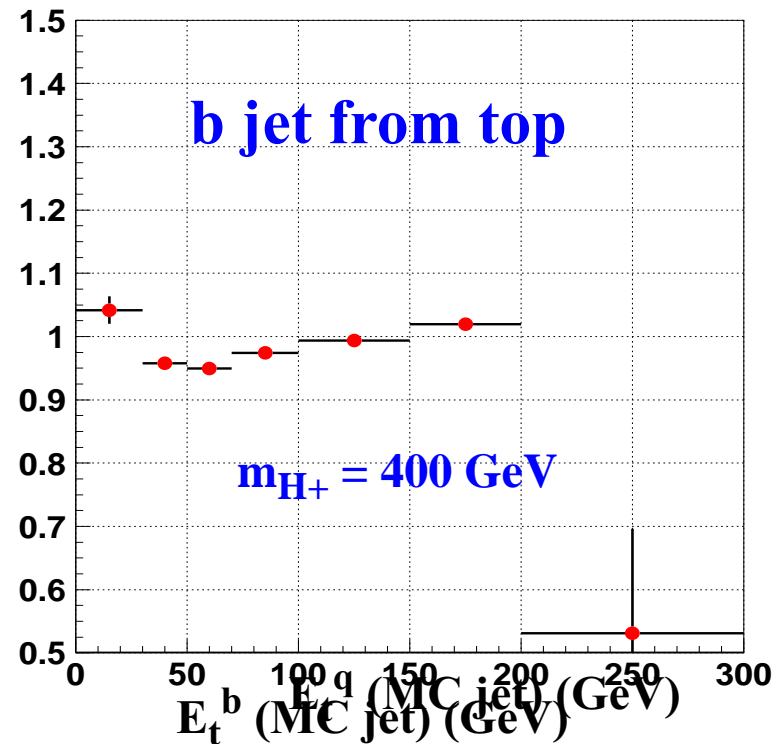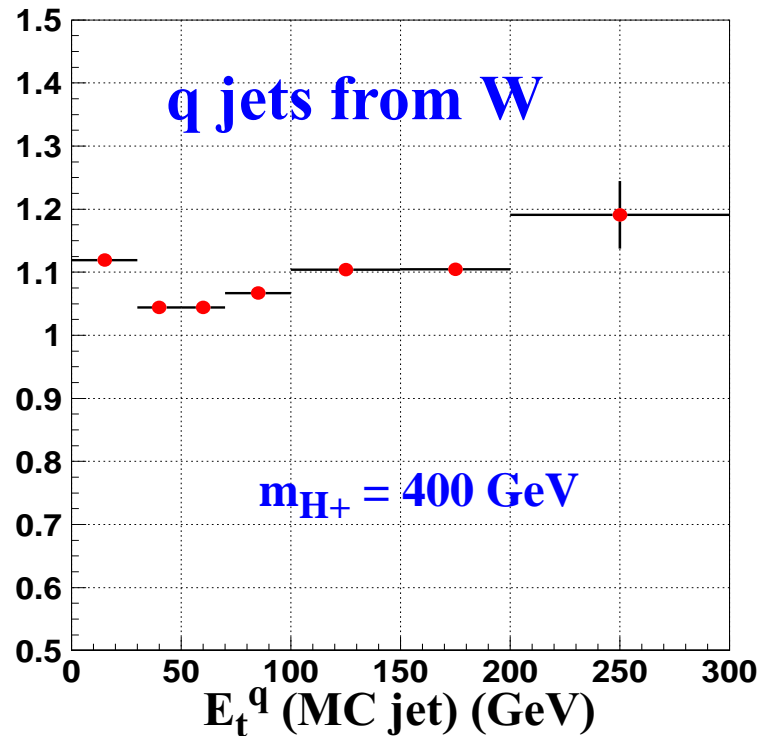

b jet

E_t measured / E_t MC jet vs E_t MC jet

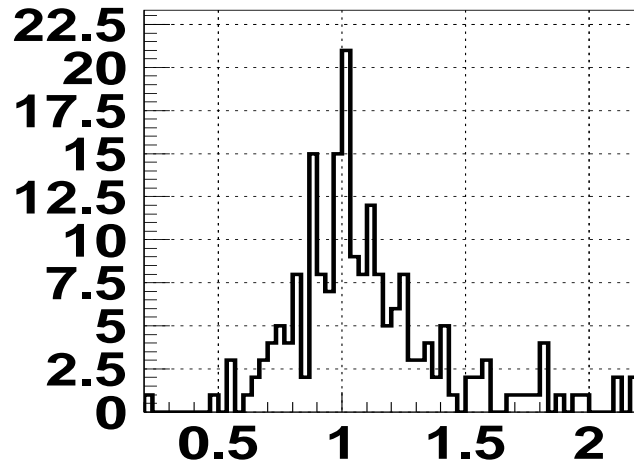## with jet energy corrections, 10^{33} cm^{2}s^{-1}

$\Delta R(q,jet) < 0.4$, $\Delta R(b,jet) < 0.4$, $\Delta R(q,MC\ jet) < 0.4$

b jet from top: E_t measured / E_t MC jet
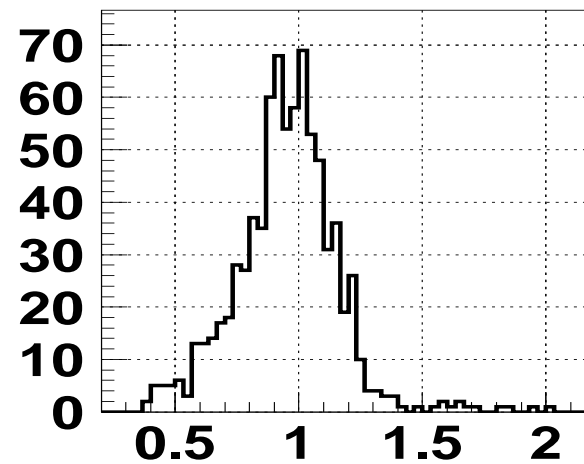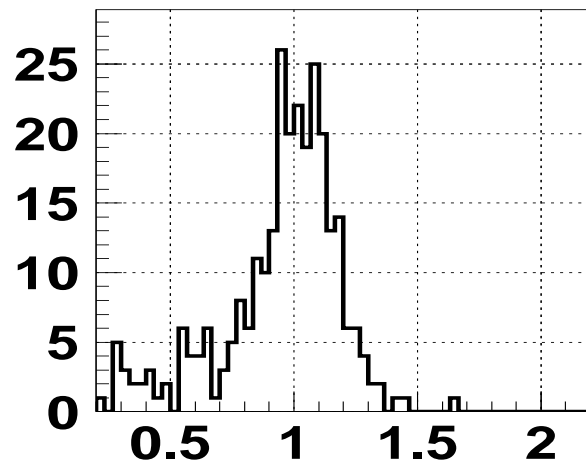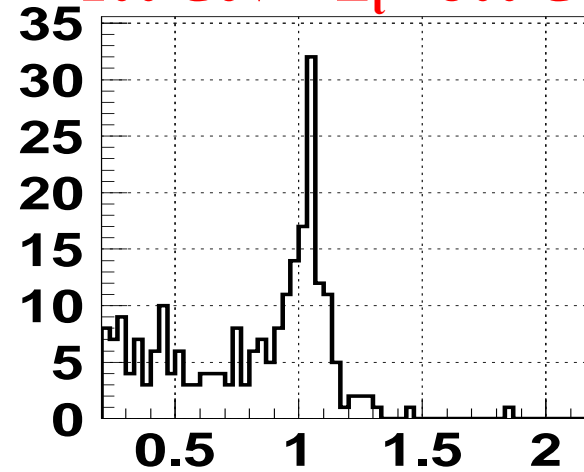
Muons in tH$^+$, H$^+$ -> $\tau\nu$, t -> jjb from b decays

muon with p_t^μ > 5 GeV in ~ 16% of events

add muons to the b-jet if $\Delta R(\mu$-bjet$)$ < 0.5, p_t^μ > 5 GeV

p_t^μ > 5 GeV

top mass with muons
reco masses, jets matching with quarks

m_{fit} = 179 GeV

σ_{fit} = 12.4%
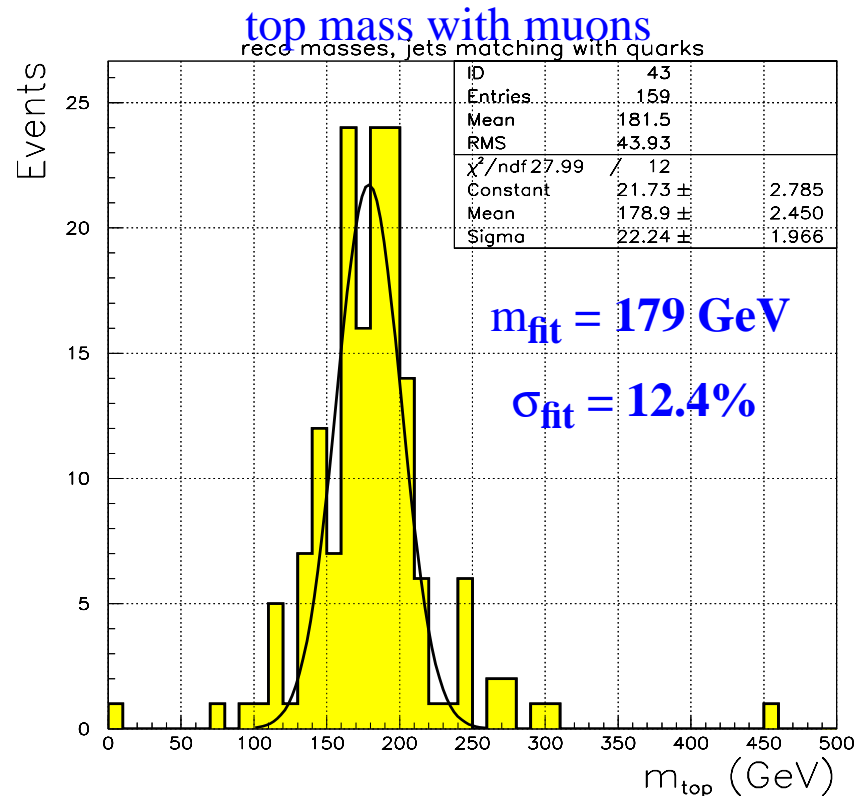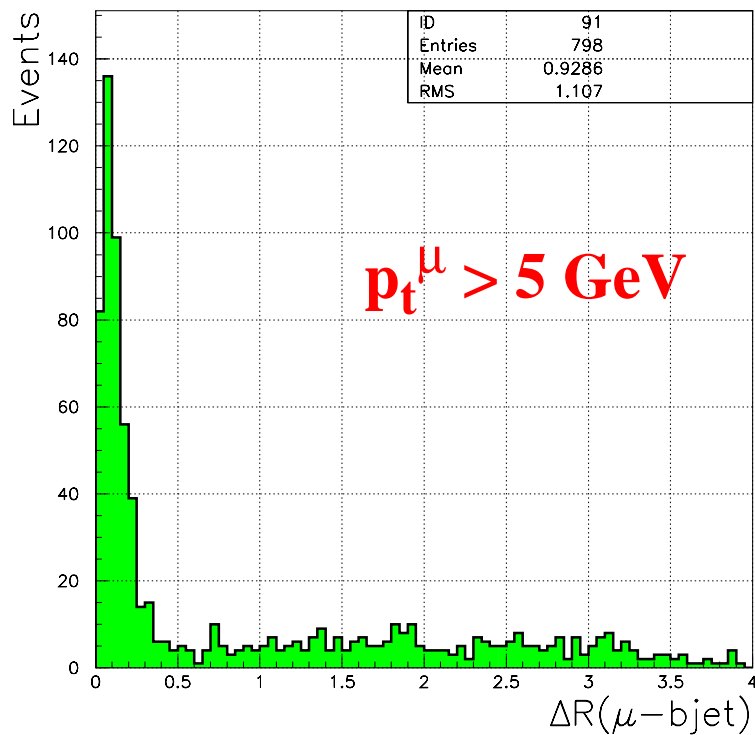
Conclusions

Preliminary results from ORCA simulation:

❐ **The Jacobian structure of $m_T(\tau\text{-jet}, E_t^{miss})$ is preserved in the signal events, no background simulation yet**

❐ **W and top mass resolution with jet energy corrections:**

	W	top
CMSJET, no pileup	11%	9.5%
low luminosity	15%	16%
low luminosity, with muons	15%	12%
high luminosity	16%	22%